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ROCK CHIPS

ALBERTA GEOLOGICAL SURVEY

Fall/Winter 2002

Mission: Provide the geoscience information and expertise needed by government, industry and the public for earth resources stewardship and sustainable development.

Alberta Foothills Coalbed Methane Potential

The Foothills of Alberta contain coal of relatively high rank, that are known to be gassy, as indicated by historic mine explosions. The best example is the Hillcrest mine explosion from 1914, which killed 189 miners and is Canada's largest mine disaster. This gas is also known as coalbed methane (CBM) and could be used as a fossil fuel.

Coal is present in the Alberta Foothills/Mountains in five zones: the Kootenay, Gething, Gates, Brazeau and Coalspur coal zones. For coalbed methane evaluation purposes, they can be divided into shallow (less than 1000 m depth) and deep (greater than 1000 m depth) coal zones. The subsurface extent of the Coalspur, Brazeau and Gates coal zones of the Moberley Creek area (northwest of Hinton) is shown in Figure 1 by the arrows.

The potential gas content of all shallow coal zones totals about 878 x 109 m^3 (31 Tcf) of CBM, which is considered an inferred, initial, in-place, coalbed methane resource estimate based on limited data. The limited amount of data on formation testing and measured gas content indicate that the inferred resource is bordering on the speculative category.

The gas content of all deep coal zones (deeper than 1000 m) totals 2.8 x 1012 m^3 (about 99 Tcf) of in-place coalbed methane gas. Consequently, the total ultimate coalbed methane resource could be 3.7 x 1012 m^3 (130 Tcf). However, coalbed methane recovery from deep coals is generally not attempted because of the high cost of drilling and the low permeability that results from high overburden load and stress.

The only (limited) Foothills coalbed methane production testing has been from the southern Alberta Kootenay Coal Zone, which is very prospective for coalbed methane production. The shallow Gates Coal Zone in the central and northern Foothills is also prospective (Figure 2), but needs to be better tested. The best potential for coalbed methane in the Coalspur Coal Zone is in the Edson area (Entrance Syncline and Triangle Zone). The Kootenay and Gates coal zones are

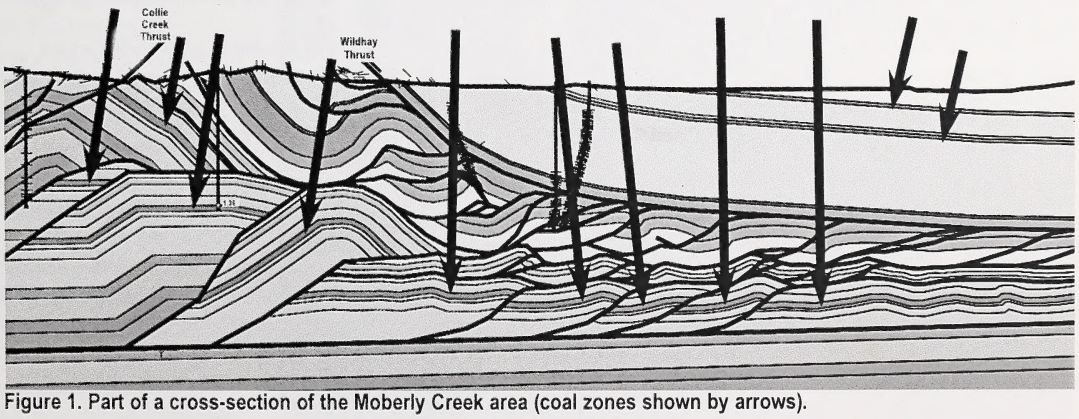

Figure 1. Part of a cross-section of the Moberly Creek area (coal zones shown by arrows).

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not well defined in the northern part of the Calgary (NTS 82O) map area. More work is warranted in this area to define these coal zones properly.❖

Figure 2. Cardinal River Coal Mine.

The following publications are the latest releases on coal and coalbed methane in Alberta.

ESR 2002-04 Hydrogeology and Stress Regime of the Upper Cretaceous-Tertiary Coal-Bearing Strata in Alberta. 28.9 MB PDF. 2002. $20.00

ESR 2002-05 Regional Evaluation of the Coalbed Methane Potential of the Foothills/Mountains of Alberta (Second Edition). 9.80 MB PDF. 2002. $20.00

ESR 2002-06 Coalbed Methane Potential of Upper Cretaceous-Tertiary Strata, Alberta Plains. 77.5 MB PDF. 2002. $20.00

SPE 7D (Digital Version) Regional Evaluation of the Coalbed Methane Potential in the Plains and Foothills of Alberta, Stratigraphy and Rank Study. 30.7 MB PDF. 2002. $20.00

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Diamond Exploration Studies in Glaciated Terrain

The AGS continued its kimberlite and glacial dispersal studies in the Buffalo Head Hills kimberlite field of northern Alberta during the 2002 field season. Fieldwork consisted of excavating trenches adjacent to and down-ice of the K4 kimberlite pipes (Figure 1) and an auger drilling program (Figure 2). The purpose of these activities is to document both indicator mineral and geochemical glacial dispersal patterns, to collect information on site-specific ice flow variations, and to determine the local Quaternary stratigraphy and till characteristics on the Buffalo Head Hills.

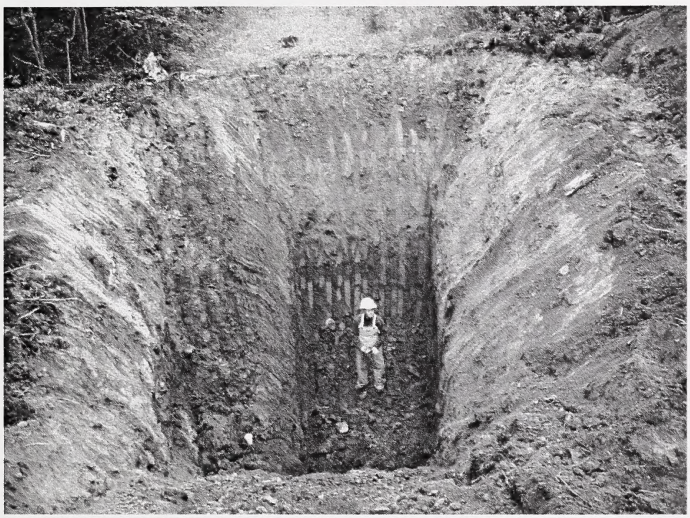


Figure 1. Trench excavated approximately 100 m down-ice of the K4A kimberlite pipe. The dark sediment at the base of the trench is basal (lodgement) till.

The glacial sediment thickness on the highlands was relatively thin, with several boreholes and one trench intersecting Cretaceous mudstone at depths less than 5 m. However, despite the thin overburden, the glacial stratigraphy was highly variable with till overlying glaciolacustrine rhythmites and glaciofluvial sands and gravels (Figure 3). The presence of fine-grained glaciolacustrine sediments underlying the till on the top of the Buffalo Head Hills remains unexplained. Two auger boreholes intersected an older, oxidized till unit underlying unoxidized till and glaciolacustrine sediments. This provides evidence that a minimum of two glaciations overtopped the Buffalo Head Hills. The regional indicator mineral and geochemical dispersal train of the kimberlite field may owe, in part, its large footprint to both glaciations.

Ice flow directional studies were conducted in the trenches at various depths to determine the history of ice flow at K4. Without erosional directional indicators, the main means of gaining this information is by conducting a till fabric. A till fabric is a statistical measure of pebbles to determine if they have a preferred orientation. Prolate (long axis diameter) clasts deposited in till under moving ice generally have a preferred orientation parallel to the direction of ice movement. At every study site, the orientations of approximately 50 clasts are measured and the results are plotted to provide a directional indicator of ice movement. Preliminary results indicate that the ice flow history in the Buffalo Head Hills is more variable than previously thought.

A detailed sedimentological study of the surface till was conducted in order to gain insight on the mineralogical and geochemical dispersal variations between till deposited by moving ice (lodgement) and till deposited by ice stagnation (ablation). At one trench, lodgement and ablation till were observed separated by a continuous bed of layered diamicton and sand (Figure 4). At other sites, the separation between the tills was indiscernible by field observations; thus other means, such as till fabrics, were used to determine the depositional history of the till.❖

Figure 2. Hollow stem auger coring on the Buffalo Head Hills.

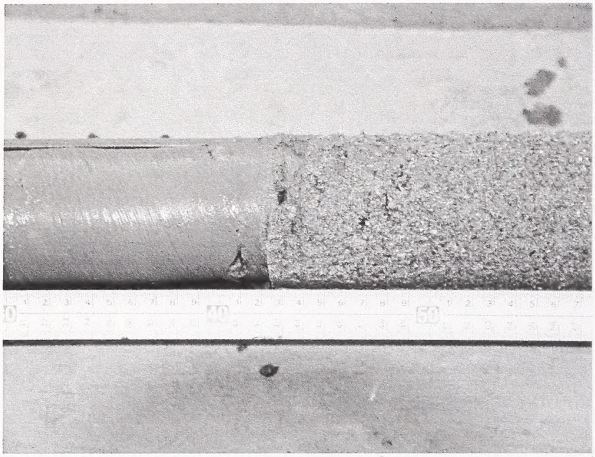


Figure 3. Fine glaciolacustrine clay and underlying coarse glaciofluvial sand. These glacial sediments underlie the surface till on the Buffalo Head Hills.

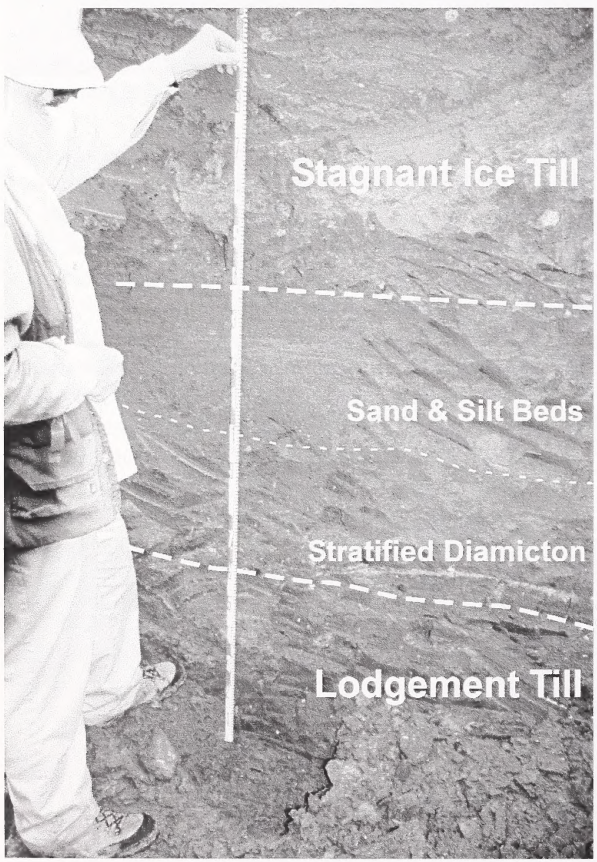


Figure 4. Trenching exposes the subtle differences and contacts between the lodgement and stagnant ice tills.

AGS Compiles Water Sampling Protocols

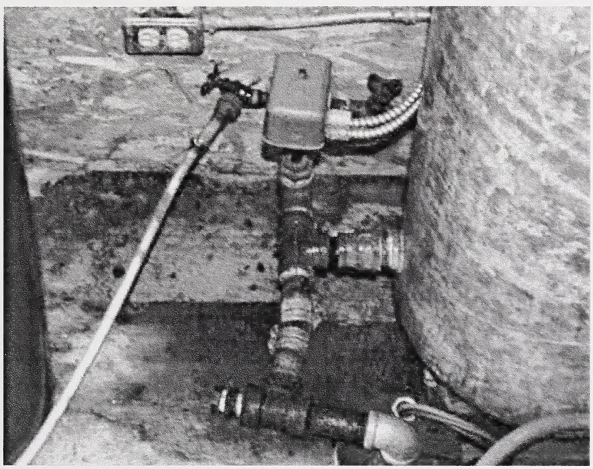
The Alberta Geological Survey (AGS) provides geoscience information and expertise needed by government, industry and the public for earth resources stewardship and sustainable development. Groundwater issues are becoming increasingly important in resource development projects from both a regulatory and operator perspective. As part of our mission, the Alberta Geological Survey is collecting and releasing much needed baseline groundwater information in areas undergoing intense resource development, especially in the relatively remote oil sands and mineral-prospective regions of northern Alberta.

The assessment of baseline groundwater conditions in areas undergoing energy development is an important and challenging task shared by government and industry. This task relies on the availability of high quality field data. In order to collect high quality data under adverse field conditions, specific protocols must be followed. Protocols ensure that every groundwater sample or measurement collected in a field program is collected in the same careful manner every time. The publication of the AGS protocols ensures that others can collect field samples and measurements in the same manner and compare their results to data collected and released into the public domain by AGS programs.

Spring water sampling set up

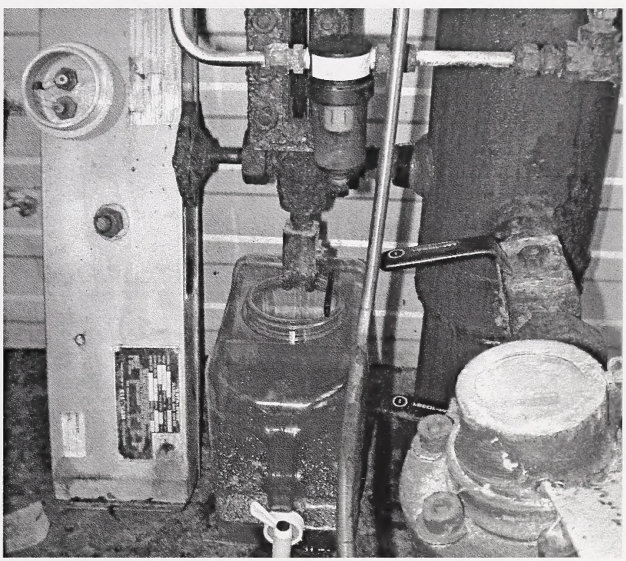
Between 1999 and 2001, the AGS conducted a groundwater-sampling program in the Athabasca Oil

Sands Area of northeastern Alberta. Groundwater from springs, water wells, oil wells and gas wells was sampled as part of the fieldwork. The purpose of the program was to document baseline groundwater conditions in advance of extensive in-situ oil sands development in the area. The information collected is being used primarily as a baseline data set. However, because of the extensive list of analytes, which includes stable isotopes, these data will be useful in further understanding the area's hydrogeology. The data will also provide invaluable geoscientific information for bitumen and mineral-resource exploration and development.



Groundwater sampling set up

A number of sources were consulted during development of the AGS field protocols. Water-sample collection procedures were documented from conversations and publications of provincial groundwater experts at Alberta universities, the Alberta Geological Survey and our colleagues at the Geological Survey of Canada and Environment Canada. Many of these procedures, particularly those concerned with sampling formation-waters from oil and gas wells, and for sampling stable and radiogenic isotopes in groundwater, were developed by Canadian university researchers and their graduate students. But they are difficult to locate in one publication. These procedures were further enhanced by compilation of relevant basic protocols available in standard publications of the United States Geological Survey and the United States Environmental Protection Agency. Those methods and protocols cover such details as preparation for water sampling, selection of equipment, cleaning of equipment to prevent cross-contamination between samples, preservation of water samples to account for time delays between field collection and laboratory analysis, and the measurement of key field parameters, like pH and oxidation-reduction potential.❖



Formation water sampling set up

Story Contact Information

The following AGS staff may be contacted for further information on their articles:

Alberta Foothills Coalbed Methane Potential	Willem Langenberg	(780) 427-0809
Diamond Exploration Studies in Glaciated Terrain	Roger Paulen	(780) 427-2851
Surficial Mapping in the Peace River Area (NTS 84C)	Roger Paulen	(780) 427-2851
Regional Till Sampling in the Buffalo Head Hills	Glen Prior	(780) 422-0854
AGS Compiles Water Sampling Protocols	Tony Lemay	(780) 422-2619

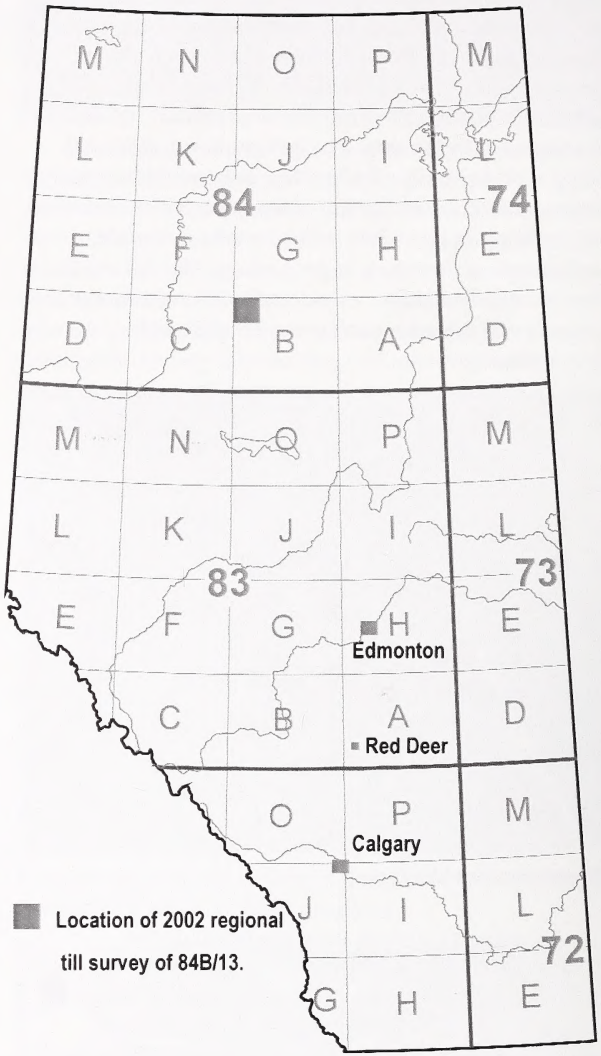
They may also be contacted via e-mail by entering the author's first name.last name@gov.ab.ca

Regional Till Sampling in the Buffalo Head Hills

Thirty-six kimberlite pipes, many of them diamond bearing, have been discovered within the southeastern Buffalo Head Hills and adjacent Loon River lowlands in north-central Alberta. The kimberlites intrude into a Mid- to Upper Cretaceous succession of flat lying, dominantly marine shales and sandstones. Several of the kimberlites form topographic and/or bedrock highs due to their greater resistance to weathering and glacial erosion relative to the soft Cretaceous sedimentary rocks. The kimberlites, with rare exceptions, are covered by till and related glacial sediments that were deposited over most of Alberta by the Laurentide Ice Sheet. In the southeastern Buffalo Head Hills, where there are the most kimberlites, the drift is commonly less than 30 m thick with outcrops of kimberlite occurring locally in a few places.

A regional till survey was conducted by the AGS this past summer in the southeastern Buffalo Head Hills within 1:50 000 map area 84B/13, an area of approximately 870 km^2. The program employed two sample densities, (i) a nominal density of 1 sample per 2 km^2 to 4 km^2 in the vicinity of the K4 kimberlite complex, and (ii) a nominal density of 1 sample per 16 km^2 throughout the remainder of the map area. In all, 55 till samples were collected during the current program. Results for these samples will be incorporated with data for till samples collected along roads in previous years by Mark Fenton, John Pawlowicz and Roy Eccles. As most road accessible sites had already been sampled, access to most of the 2002 sites was gained using quads. These vehicles proved effective due to the extensive petroleum exploration and development that has occurred within the region. The till survey area is crossed by numerous seismic cut lines and the more recent of these can be travelled by quad. Additional quad access occurs along two pipeline corridors that cross the area. A helicopter was required to reach only one sample site.

At each site, 25 to 30 kg of till were collected in a large plastic pail along with a small sample (about 0.5 kg) in a plastic bag. In order to sample relatively unmodified till, the samples were collected from a depth where matrix carbonate, detected by reaction with dilute HCl, is present (weathering processes result in the removal of carbonate from near the surface). At most sites, this required sampling at minimum depths of 80 to 120 cm below surface. Where possible, samples were collected opportunistically by excavating existing banks (e.g., road cuts or borrow pits). However, most samples were collected from pits dug by hand. The large samples were collected in order to determine if certain heavy minerals characteristic of kimberlite are contained within the till. The kimberlite indicator mineral (KIM) suite includes Cr-rich garnet, Cr-diopside, olivine, ilmenite and chromite. Geochemical analyses are obtained using the small samples. Previous till samples from the K4 kimberlite area have returned KIM counts of up to 263 grains in 25 kg of till. The 2002 program was designed to investigate the regional distribution patterns of KIM grains within till in an area of known kimberlites and to demonstrate the effectiveness of drift prospecting as a diamond exploration technique in northern Alberta.❖



Surficial Mapping in the Peace River Area (NTS 84C)

As part of a multi-year initiative, the Alberta Geological Survey continued its surficial mapping program in the Peace River map area. The Peace River District of Alberta has been subjected to several geological studies in past years. The focus of this prior work was mainly directed toward the numerous bedrock exposures in the Peace River Valley, the large gravel resource and aquifer that underlies the town of Grimshaw, and most notable, the long history of landslides that affect the region. The recent Quaternary studies in the Peace River region provide crucial information on the surface stratigraphy and deposit characteristics that have direct implications for exploration of diamonds using drift prospecting, aggregate exploration and landslide processes.

Figure 1. The scenic Peace River Valley at the town of Peace River.

Fieldwork was conducted during July and September and provided continuity with last year's mapping program in the Peerless Lake (NTS 84B) map area to the east. Particular attention was paid to surface stratigraphy, ice flow indicators and the highly variable nature of the surface sediments. Reconnaissance-level till sampling for diamond indicator minerals and geochemistry was completed. Extensive progress was made in unravelling the glacial and post-glacial history of the region.

The physiography of the region is dominated by the Peace River Valley. This impressive and scenic feature was formed during post-glacial times as the Peace River and its tributaries, such as the Smoky and Heart rivers, incised through the Quaternary sediments and into the underlying bedrock (Figure 1, above.). The Peace River separates the Buffalo Head Hills to the east and the Whitemud Hills to the west. The Peace River District is part of a large geological feature that makes up most of the fertile farmland in the region. The flat topography and stone-free grain fields immediately adjacent to the Peace River is a result of being the former lake bottom of Glacial Lake Peace, which inundated most of the region below 610 m (above current sea level). During early deglaciation, the continental ice sheet (Laurentide Ice Sheet) retreated northward and down-drainage, essentially blocking drainage and ponding the glacial meltwaters at the ice margin. Glacial Lake Peace was one of the larger glacial lakes that submerged the plains of Alberta; it extended far into British Columbia to the west and reached as far north as High Level prior to its final drainage.

The Quaternary stratigraphy in the region is complex. Scientific highlights from this summer's fieldwork provide new information to augment the existing published stratigraphic record. From oldest to youngest, the main surficial deposits comprise:

1. Large expanses of preglacial sand and gravel occur in the vicinity of the town of Grimshaw. Aggregate operations have been mining this valuable resource for years and continue to provide the region with an abundant supply of sand and gravel (Figure 2). This unit is extensive west of the town of Peace River and as far north as the Whitemud Hills.

2. A newly discovered and potentially older glacial till was discovered on the southwestern flank of the Buffalo Head Hills. This sandy, non-calcareous till underlies and contrasts sharply with the ubiquitous clayey, calcareous grey till that occurs at surface throughout the region (Figure 3). Although absolute dates cannot be determined, it is believed this older till marks the most westerly known site of Early Wisconsin continental glaciation in west-central Alberta.

3. A complete Late Wisconsin glacial sequence is preserved in the Peace River Valley. As the ice sheets advanced southward (up-drainage) into the region, ice-dammed drainage caused proglacial lakes to form and fill in the lower part of the valley. This lacustrine

Figure 2. Ancient deltaic foresets deposited in preglacial times exposed in active aggregate pit near the village of Brownvale.

Figure 3. Older orange oxidized sandy till underlying Late Wisconsin grey unoxidized till.

sediment coarsened upward into sands and gravels as the ice margin advanced. During glacial maximum, ice overrode the previously deposited lacustrine sediments and deposited till over the entire region. Till thickness varies, but is notably thinner on the west side of the Peace River (Figure 4). Deglaciation of the region resulted in minor localized ice surges and, of course, Glacial Lake Peace. The exact lifespan of the lake is unknown, but it was stable at certain surface elevations long enough to develop shorelines and deposit over 20 m of silt and clay in its former basin (Figure 5), currently occupied by the modern Peace River. Eskers and meltwater channels are rare in the region (Figure 6), except at higher elevations on the flanks of the Buffalo Head Hills where the ice sheet had stagnated and melted much slower.

4. Glacial Lake Peace drained in the early Holocene and the Peace River immediately began downcutting through the Quaternary sediments. There are several terrace levels that record the rapid rate of incision. These older terraces are now excellent sources of aggregate in the region. Landslides also occurred throughout the Holocene and continue to affect the region today.

Figure 4. Thin till (<5 m) deposited over an outcrop of Dunvegan Sandstone.

Finally, the summer fieldwork was highlighted with the discovery of a spectacular exposure of mega-scale soft sediment deformation structures at Sagitawa Lookout, south of the town of Peace River on Highway 744 (Figure 7). These impressive features occur above the landslides and have formed from sudden dewatering of pore-saturated sediments in the upper Glacial Lake Peace sequence. The sheer size and magnitude of the dewatering structures seen at this roadcut are unparalleled in glaciolacustrine exposures observed throughout the Prairies. The impetus that caused the dewatering remains unknown at this time.❖

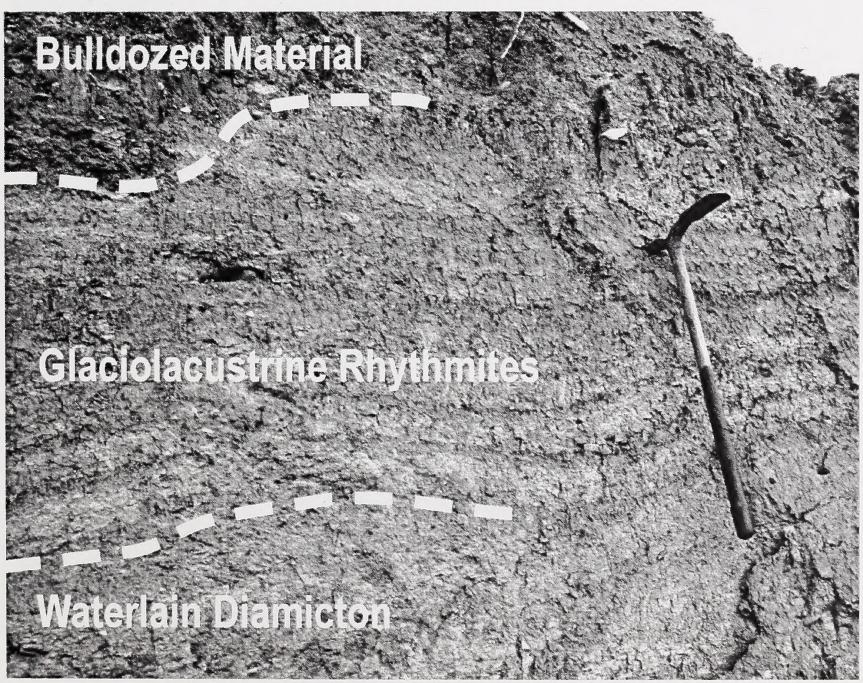


Figure 5. Stratified waterlain diamicton grading up into large glaciolacustrine silt and clay rhythmites. (Top layer is disturbed (bulldozed) material.

Figure 6. A rare low relief esker in the Peace River District northeast of Cardinal Lake. Telephone pole is at esker crest.

Figure 7. Spectacular dewatering structures exposed in roadcut near Sagitawa Lookout, Peace River.

Recently Released AGS Publications

ESR 2000-01 Structural-Emplacement Model for Kimberlite Diatremes in Northern Alberta. 345 MB PDF. 2002. $20.00

ESR 2000-12 Quaternary Geology and Till Geochemistry, Wapiti Map Area (NTS 83L). 9.67 MB PDF. 2002. $20.00

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GEO 2002-03 Carbon-14 Dating of Groundwater from Selected Wells in Quaternary and Quarternary-Tertiary Sediments, Athabasca Oil Sands (In Situ) Area, Alberta. 966 KB PDF. 2002. $20.00

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INF 125 AGS and Selected Industry Contributions from 2002 11th Annual Calgary Mining Forum and Alberta Geological Survey Minerals Section Open House. 277 MB. 2002. $20.00

Map 207D Quaternary Geology of Southern Alberta (Digital Version). Arc/Info datasets, ArcView project, ArcExplorer project, EPS and PDF files. 2002. $20.00

Map 213D Quaternary Geology of Central Alberta (Digital Version). Arc/Info datasets, ArcView project, ArcExplorer project, EPS and PDF files. 2002. $20.00

NOTE: The following 5 maps are sold together on one CD for $25.00

Map 240 Surficial Geology of the Calling Lake Area, AB. (NTS 83P SW). 3.21 MB PDF. 2002.

Map 241 Surficial Geology of the Sandy Lake Area, AB. (NTS 83P NW). 3.69 MB PDF. 2002.

Map 242 Surficial Geology of the Wandering River Area, AB. (NTS 83P SE). 3.88 MB PDF. 2002.

Map 243 Surficial Geology of the House River Area, AB. (NTS 83P NE). 3.54 MB PDF. 2002.

Map 251 Surficial Geology of the Pelican Area, AB. (NTS 83P). 5.13 MB PDF. 2002.

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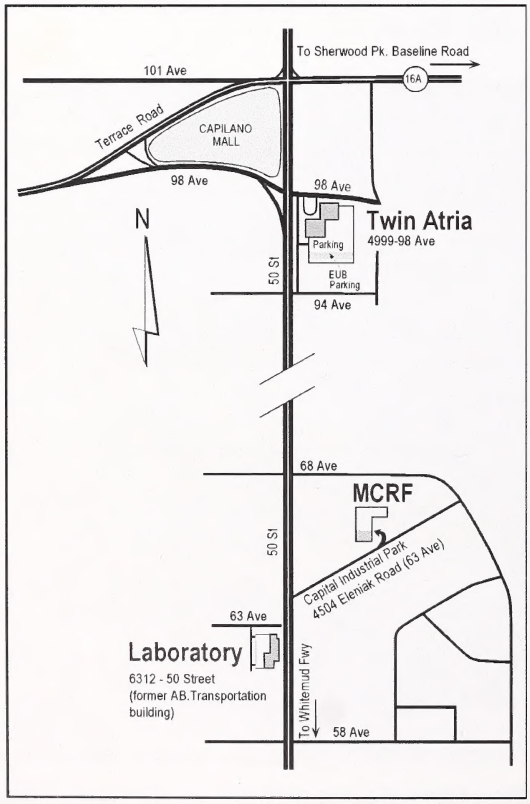

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SPE 52 Guide to Recent Publications on Inorganic Water-Rock Interactions Relevant to Deep-Well Wastewater Disposal in Carbonate-Evaporite Formations in the Athabasca Oil Sands Area, Alberta. 396 KB PDF. 2002. $20.00

SPE 55 Petrography of Ardley Coals, Alberta, - Implications for Coalbed Methane Potential. 2.28 MB PDF. 2002. $20.00

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The main office of the Alberta Geological Survey is located at
4th Floor, Twin Atria Building
4999 - 98th Avenue
Edmonton, Alberta
Canada T6B 2X3
Tel: (780) 422-1927
(780) 422-3767 Information Sales
Fax: (780) 422-1459
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Tel: (780) 427-4663
e-mail: EUB.AGS-Library@gov.ab.ca

Our Mineral Core Research Facility (MCRF) is located at

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Edmonton, Alberta

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